DOCUMENT RESUME

ED 280 444 IR 012 580

| | |
|---|---|
| AUTHOR | Hebenstreit, Jacques |
| TITLE | Applications of Computer Science to the Management and Evaluation of the Educational Process. |
| INSTITUTION | United Nations Educational, Scientific, and Cultural Organization, Paris (France). Div. of Structures, Content, Methods and Techniques of Education. |
| REPORT NO | ED-84/WS/10 |
| PUB DATE | 10 Apr 84 |
| NOTE | 19p.; For a complementary report on computers in developing countries, see IR 012 582. |
| PUB TYPE | Information Analyses (070) -- Reports - Descriptive (141) |
| EDRS PRICE | MF01 Plus Postage. PC Not Available from EDRS. |
| DESCRIPTORS | *Computer Assisted Instruction; *Computer Managed Instruction; *Developed Nations; *Educational Administration; Foreign Countries; Management Information Systems; Media Research; State of the Art Reviews |
| IDENTIFIERS | Canada; France; Japan; United Kingdom; United States; USSR; West Germany |

ABSTRACT

This synthesis of reports from authors representing seven different countries discusses computerization as it applies to the management and evaluation of the educational process at all levels in developed countries. Focusing on the computerization of educational administration, the first of three sections of the paper suggests that advantages of computerization would include speedier compilation of more reliable and detailed statistics for decision making and for forecasting at the national and regional levels, and the saving of time for administrators through the automation of various tasks and school activities at the building level. The major problem cited is the divergent point of view between teachers and civil servants as to the management of educational systems. The second section considers the benefits of computerized management of educational processes, e.g., organizing timetables, scheduling students into elective courses, management of students' grades, relations with students' parents, the control of book loans to students, and management of the teaching process as such (computer-managed instruction, or CMI). The focus of the final section is computer-assisted instruction (CAI), which is discussed in the following contexts: the development of various teaching methods; policies in developed countries for the implementation of CAI and problems which prevent its extended use; and the state of the art in hardware, programming, and teacher training. The seven authors and the topics of their studies are listed in the introduction. (BBM)

**********
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
**********

# Division of Structures, Content, Methods and Techniques of Education

ED-84/WS/10
PARIS, 10 April 1984
Original: French

UNITED NATIONS EDUCATIONAL,
SCIENTIFIC AND CULTURAL ORGANIZATION

## APPLICATIONS OF COMPUTER SCIENCE TO THE MANAGEMENT AND EVALUATION OF THE EDUCATIONAL PROCESS

Jacques Hebenstreit
Head of the Department of Computer Science
Ecole Supérieure d'Electricité
Plateau du Moulon
91190 Gif/Yvette (France)

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY
Suzanne Adlung
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Unesco, Paris

Reproduced by permission of
UNESCO 2

ED-84/WS/10
PARIS, 10 April 1984
Original: French

UNITED NATIONS EDUCATIONAL,
SCIENTIFIC AND CULTURAL ORGANIZATION

# APPLICATIONS OF COMPUTER SCIENCE TO THE MANAGEMENT AND EVALUATION OF THE EDUCATIONAL PROCESS

Jacques Hebenstreit
Head of the Department of Computer Science
Ecole Supérieure d'Electricité
Plateau du Moulon
91190 Gif/Yvette (France)

Etude préparée sous contrat avec l'Unesco

BEST COPY AVAILABLE



BEST COPY

INTRODUCTION

This document attempts to provide an overall view of the following seven reports prepared at Unesco's request:

Professor J. Broderick (United Kingdom): Computer-managed learning - a case-study;

Dr S. Charp (United States of America): Case-studies concerning the use of computers-managed learning in secondary schools;

Professor V.N. Chetverikov (Union of Soviet Socialist Republics): The use of computers in the management and evaluation of instruction in the higher educational establishments of the Union of Soviet Socialist Republics;

Professor J. Hebenstreit (France): L'informatisation de la gestion du système éducatif français;

Professor H. Nishinosono (Japan): Computer-managed instruction in the Japanese secondary schools;

Dr R. Peschke (Federal Republic of Germany): Computer-assisted school management in the Federal Republic of Germany;

Dr I. Waniewicz (Canada): The use of computer-managed learning for media-based informal adult education.

Although each report is devoted to a particular aspect of the subject, the seven together cover the entire field of computer science as applied to the management and evaluation of the educational process. Moreover, the whole question can be broken down into three fairly distinct fields:

educational administration, the two complementary aspects of which are described by J. Hebenstreit and R. Peschke;

computer-managed instruction, which is dealt with by J. Broderick, S. Charp, H. Nishinosono and I. Waniewicz;

computer-aided instruction, an area explored by V.N. Chetverikov and H. Nishinosono.

## 1. COMPUTERIZATION OF THE PUBLIC ADMINISTRATION OF EDUCATION

### 1.1 Identifying the problem

The widespread use of computers in larger government departments of the developed countries from the end of the 1960s naturally led to consideration of their being introduced in the public administration of education.

The aim was to improve the functioning and steering of the educational system at all levels.

(a) At the national and regional levels:

speedier compilation of more reliable and detailed statistics to ensure that educational resources (buildings, teaching staff, financing) were more closely adapted to the needs of the school population;

the provision of statistical series making it possible to improve forecasting of the development of the educational system in the light of population growth.

(b) At the school level:

saving of time for school administrators through the automation of a number of tasks (supervision of students' grades and files, issuance of various administrative certificates, updating and printing of student rosters by grade or field of study, notification of exams, etc.);

saving of time for certain conventional school activities (arrangement of timetables, allocation of subjects to teachers and students on basis of multiple-choice criteria, etc.).

As mentioned in the introduction, the public administration of education has not yet been fully computerized and all the projects being undertaken in this field are, for the most part, still in an experimental stage.

There are several reasons why computerization is being introduced into the public administration of education at a slower pace than into other administrative sectors, not the least of which is no doubt inadequate funding. The main reason, however, is to be found in the nature of the educational system itself, embracing, on the one hand, hundreds of thousands of teachers and millions of pupils in schools throughout the nation and, on the other, thousands of civil servants responsible for administering the system.

The existence of these two bodies - teachers and civil servants - leads to some duality in approaches to the educational system.

Teachers, and more particularly teachers having administrative responsibilities in schools, must subordinate their administrative functions to their educational functions, which means that activities such as decision-making, planning, organization, implementation of objectives and guidance, must be geared to the improvement of teaching.

The civil servants whose job is to manage the educational system, however, have a tendency to see their objective as the overall optimization of the system in terms of the management of budgetary material and human resources, in other words, managing education in much the same way as a business concern is managed.

This dual approach to the functioning of the educational system is, however, usually perceived only subjectively although it may, on occasion, be expressed in sporadic conflicts of varying intensity.

The computerization of the public administration of education makes this duality much more objective since it gives, as it were, concrete reality to it in the automation of an increasing number of administrative procedures.

The very development of technology has heightened awareness of these divergent points of view.

Ten years ago, the cost of computers was so high that only the central government could afford to use them.

Under such conditions it was inevitable that at first priority in the matter of computerization should be given to the overall management of the educational system without any consideration of the use of computers to improve education in the schools.

During this initial phase the greater inflexibility of procedures inevitably accompanying computerization made the teaching profession view the computerization of the education system in a rather negative way.

Since, however, the active co-operation of teachers and administrators in the schools was essential for the smooth operation of the central data processing system, the result generally and in France particularly (because of the highly centralized system of education) was a very energetic policy of co-ordination at all levels of the educational system in defining the objectives and methods of computerization.

The centralized use of computers created a number of problems: firstly, schools had to post, in standardized form, information which might then be returned for them to correct the inevitable errors and send it off again; secondly, school administrative personnel felt that they were putting in a considerable amount of work to supply this information without any alleviation of their regular work-load, quite the contrary.

The rapid development of technology and the concomitant reduction in the price of computers helped to alter the terms of the problem; in particular, the appearance of micro-computers and the possibility of linking computers to form computer networks was to call into question the whole process of computerizing the educational system.

Establishment of regional centres for information processing

Initially, the lower cost of computer equipment made it possible to decentralize the processing operation by creating regional processing centres that were closer to schools. The regional centres were often linked to a regional division of the educational system (the Länder in the Federal Republic of Germany and the Rectorats in France) and resulted in more knowledgeable management and more detailed statistics at the regional level. The regional centres, in turn, supplied the national centre with the information it required.

Decentralization offered several advantages over a single central system:

information input was easier because the volume of information collected was smaller and the time required for the transmission of information to schools for revision of incorrect or incomplete information and its return was reduced;

information originating in the regional centres and bound for the national centre could be transmitted on magnetic tape, that is, in a form directly usable by the national centre;

more efficient management and more detailed statistics resulting from the additional processing of information at the regional centre the results of which were of little or no interest to the central government.

On the other hand, decentralization also had some drawbacks:

the computer equipment used by the different regional centres was seldom of the same type (this was even true for France despite stringent national policy concerning computer equipment for government departments), which meant that as many different kinds of software had to be prepared as there were types of equipment. Apart from the extra cost involved, this was very time-consuming;

the software of each regional centre had to be compatible with that of all the others for there to be magnetic tape files compatible with each other and with those of the national centre. This meant that there had to be prior consultation and co-ordinated updating of the software of the different processing centres whenever a decision was made to modify processing operations.

Appearance of micro-computers

Initially, as we have said, the first step was obviously to computerize the overall management of the educational system, a move which triggered off a defence mechanism in school administrators in so far as they felt that it made the central government administration more rigid, and at the same time sacrificed something which they regarded as important, namely the adaptation of the administrative system to the requirements of education and educational innovation.

Moreover, the increase in the number of forms to be filled in and the very rigid format of sections of the different forms that did not always apply to local school conditions gave rise not only to additional work for school administrators but also to some doubt as to its usefulness.

The introduction of micro-computers in 1975 put a different complexion on the whole problem of the computerization of educational administration, since individual schools were now in a position to acquire a computer.

An increasing number of head teachers and administrators, impressed by the gains in productivity effected by the use of computers in the management of industrial and commercial firms, purchased micro-computers as a means of lightening their administrative load.

Micro-computers started being used in some schools to manage student files by class, and school administrators also used them to set up teachers' timetables, print administrative documents, etc.

It is absolutely certain that the use of a micro-computer in schools can considerably help administrative personnel in the performance of their duties provided, however, that the computer system's software is comprehensive and flexible enough to be adapted to the varying requirements of local conditions.

The fact of the matter is, however, that such software is not available on the market, with the result that the computer programmes needed by the system that has been purchased have, in most cases, to be written on the spot by one or more computer buffs on the teaching staff usually in their own time.

This situation is unsatisfactory on four counts:

computer programmes written by amateurs bear no resemblance to those written by professionals: they are often so unnecessarily complicated that it is extremely difficult to locate programming errors and in general practically impossible to make any changes owing to the lack of serious explanatory documentation on the programme in question; finally, for the reasons just mentioned, the software has no further practical use if the teacher who produced it is transferred or retires, since he is the only one who can cope with an emergency;

while it takes a great deal of time even for a specialist to produce a computer programme, the time a teacher must spend makes it prohibitive, as he can only do it outside his regular working hours;

as a rule, micro-computers are not purchased as the result of a study of the processing operations the machine is to perform that would make it possible to define the minimum specifications of the equipment required (capacity of immediate access store, central processor time, size and access time of auxiliary store in the form of magnetic tape cassettes or magnetic disks, etc.).

In fact, quite the opposite practice is followed: the computer is purchased in accordance with the funds the school has at its disposal and then the processing operations are adapted to the machine, with all the attendant frustrations (data processing time that arouses scepticism about the superiority of machine-over manual-processing, impossibility of introducing all the files into the machine without causing the memory to overflow, etc.). School administrators thus learn from bitter experience that, contrary to the claims of certain advertisers, a school with a thousand pupils cannot be properly managed with a $1,000 computer;

owing to the extreme diversity of micro-computer models purchased by schools (as many as 17 different models were found in one area grouping 54 schools), software cannot be transferred from one school to another and therefore every school has to start from scratch.

Finally, micro-computers used at the local level raise the problem of format standardization for the transmission of data to a higher level (regional centre) - on a flexible disk, for example - which has already been mentioned in connection with regional centres' exchange of data with the national centre.

It is thus clear that nothing is to be gained from the installation of micro-computers in schools without regional co-ordination involving the standardization of software; this alone will obviate the need for each school to start at square one. In fact proposals regarding standardization are met with veiled resistance by the schools which, rightly or wrongly, feel that the standardization of management techniques and methods will inexorably lead

to the subordination of the educational system to the demands of computerized management. Perhaps such apprehensions could be allayed by the development of computer networks.

Computer networks

During the past few years the computerized management of industrial and commercial firms has undergone rapid development, involving the establishment of computer networks linked together by communication channels (local, national and transnational networks).

There is, therefore, a temptation to transpose this set-up to the public administration of educational systems in which all computers from the local to the national level would be linked together by communication lines, whether telephone circuits or data transmission channels.

Though any attempt to describe such a system or forecast its implications lies in the realm of science fiction, since no such network has ever been put into operation, it seems fairly clear that we are moving towards the establishment of a network system and it is perhaps not too early to give some serious thought to the problem.

Conclusion

The first efforts to computerize the public administration or educational systems date back to the end of the 1960s.

Since that time, comparatively little progress has been made and even today achievements in this field are limited and rarely go beyond the experimental stage. The introduction of micro-computers around 1975 has not significantly altered this state of affairs, and achievements in this new field are also restricted and remain largely experimental.

There is no doubt that the movement towards computerization will continue and gain momentum in the years ahead, and the chances are that efforts will be focused on the development of computer networks, bringing to the fore new problems concerning the organization and techniques of educational management information systems.

## 2. - Computerized management of educational processes

### 2.1. - Identifying the problem

The management of educational processes, in the broad sense, differs from the management of educational administration in that it is much more closely related to educational activity although it may also include administrative activities.

In general, and for reasons of convenience, the expression 'management of educational processes' is used to refer to all management activities at school or classroom level, as these activities depend largely on the structure of the educational systems and the public or private status of the schools.

Pursuing this distinction further, it may be said that public administration basically includes everything relating to the buildings and their maintenance, and the financial aspects of staff management, whereas the management of educational processes is concerned more specifically with:

the organization of timetables;

the allocation of students to elective courses;

the management of students' grades;

relations with students' parents,

the control of book loans to students;

the management of the teaching process as such.

### 2.2 - Organization of timetables

A school containing a large number of classrooms, classes and teachers has to have a timetable for each day of the week allocating a classroom to a teacher and a class for each individual period. The problem, which is a classical problem of 'resource allocation', becomes more complex as the number of constraints increases (number of hours of compulsory courses per student, special nature of certain classrooms such as those used for practical work, need to divide a class into two groups for certain activities, timetable preferences of the various teachers, etc.).

Various software packages enabling this problem to be dealt with by computer have been offered, but few of them are actually used, as this problem is almost always resolved in practice by the method of approximation through a series of compromises with the individual teachers, since the manner in which the problem is posed makes it impossible to satisfy all the teachers' requests and therefore involves negotiations which sometimes prove difficult.

Nevertheless, interactive software is available for timetabling which permits the various constraints to be fed into the computer in order of decreasing importance. The timetable is gradually filled out on the computer display and any subsequent corrections are made directly on the computer keyboard so that it is not necessary to draw up a new timetable with each series of corrections.

In fact, each time that a teacher and a class are allocated a classroom through the keyboard, the computer automatically updates:

for each teacher: the number of teaching hours already allocated;

for each class: the table indicating the number of class periods already allocated in each subject;

for each classroom: the table showing the periods already allocated.

A considerable amount of time may be saved by using this semi-automatic method for timetabling instead of the manual method.

2.3 - The allocation of students to elective courses

In some classes, the students may choose elective courses (for example, some students may choose to learn a modern language while others in the same class decide to study Latin or drawing). This poses several problems:

if access to these optional activities is dependant on satisfactory grades in certain subjects, it is necessary to check that each student has the qualifications necessary for access to the courses which he has selected;

all applicants from all parallel classes (if there are more than one) must be put together to form one new class (or more than one if the total number of applicants exceeds a certain limit);

these optional activities must take place at the same time during the same period.

The use of a computer can save a great deal of time in these cases too, by automating the operations.

2.4 - Management of students' grades

In the course of his or her school career each student obtains a certain number of grades (for written exercises, oral tests, homework, etc.) in each subject, which the teacher uses as a criterion of the student's performance in this subject.

With some software packages, the results of an exercise done by the whole class may be fed into the computer in order to obtain the average of all the grades awarded in the class for that exercise, a graph showing the distribution of the students according to the grades awarded, the total or average of each student's marks since the start of the school year or, finally, a comparison of that class's marks with those awarded in previous years.

2.5 - Relations with students' parents

In practically all schools, the administration sends the parents of students a periodic report on their marks in the various subjects taught. This means that all teachers must pass on their grades to the administration, thus imposing a very heavy burden upon it.

There are examples of such activities being managed by computer, but they have only proved really effective where teachers and administration have access to

a single central computer with which they communicate through terminals. In such conditions, it is possible to establish a data base within the computer, including a single file for all students and in which all information relating to a student fed in through a terminal is automatically stored on the record reserved for that student. If the administration possesses a terminal with a word-processing system and access to the data base, it can have an automatic print-out of all the students' grades, with optional 'personalized' comments such as 'John must try harder in chemistry' or 'Peter is doing very well but must pay attention in mathematics', etc. which are produced automatically by an in-built mechanism after the programme has examined the marks awarded to each student in the different subjects.

Software of this sort is actually being used on an experimental basis in some schools in the United States of America but requires centralized data processing, with all the grades stored in a single computer. This type of software can not be used if each teacher has an independent microcomputer, as he would only be able to store his own grades.

A system of this sort is also used in Canada to handle the mail for students of distance courses broadcast by Canadian television, as the number of students is such that regular contact with each one would be impossible on the basis of manual processing.

2.6 - Control of book loans

All schools normally possess a library and/or a documentation centre open to the students on a self-service basis.

Some school libraries use a microcomputer which enables the students to consult the file of available works which they can access via the name of the author or a series of keywords relating to the content of the works which they wish to consult. The objective here is not only to simplify access to information, but also to familiarize the students with general methods of access to data banks, which they will have to consult later. Lending is also computerized and the librarian can enter on the computer keyboard the name of the student and the references of the work borrowed. It is, therefore, possible to check the availability of a work by consulting the computer and also to have printed automatically the reminder letters to students who have not returned the work or works borrowed from the library within the period allowed.

These software packages are not, in fact, specific to schools, being used in a much more sophisticated form in an increasing number of libraries.

2.7 - The management of the teaching process as such

The management of the teaching process is generally known as 'Computer Managed Instruction' (C.M.I.), but it takes widely different forms, depending on the role assigned to the computer.

2.7.1 - The computer as educational counsellor

In this form of C.M.I. each student has free access to the computer terminals. When a student wishes to study a particular subject, he sits at a terminal and types on the keyboard the name of subject which he wishes to study. The computer then requests some information from the student concerning his age, his previous studies, etc. and it then sets him a series of exercises designed to assess the level of his knowledge. On the basis of the answers given by the student, the

computer sets him or her a programme lasting a week or a fortnight, with books to read, courses to attend and exercises to do, and asks the student to return at the end of the period. When the student returns, the computer asks him to type in the answers to the exercises which it had set and sets him a series of tests designed to check his assimilation of the new knowledge. The computer tells the student how well he has done in the tests, drawing his attention, if need be to weak points or shortcomings, and then gives him a new work programme for the following period, and so on.

Observations: This is an ideal situation and does not correspond to any system now in existence, as it is extraordinarily difficult to devise such programs.

There are, however, experimental systems which incorporate some of the functions described above and which can assist educational counsellors by taking over part of their work. Although it is admittedly difficult to devise a series of automatically corrected tests which would provide a clear and reliable picture of a student's knowledge of or skill in different areas, it is still very useful for an educational counsellor to have the results of preliminary tests to hand during any subsequent interview with the student. In the course of such an interview, the educational counsellor may, indeed, amend the results of the tests in accordance with the personality of the student, and remedy the over-systematic and impersonal nature of the results provided by the computer.

2.7.2 - The computer as an evaluation instrument for the student

The simplest use of the computer for evaluation is its use by students for self-assessment.

The software must include groups of tests prepared by the teacher, who will tell the students each week which series of tests corresponds to the lessons he or she has given during that week. The students may then take these computer tests, at their own convenience. At the end of the series of tests the computer not only provides an overall assessment of the knowledge acquired by the student, but can diagnose his weak points and indicate which items in the course should be revised or studied more thoroughly.

Observations: The 'diagnosis of weak points' and 'suggestions for revision' are the most difficult processes to convert into software as it is almost always very difficult to deduce a student's weak points by means of automatic processes, solely on the basis of his answers to one or more series of tests. 'Errors of diagnosis' are, therefore, sometimes inevitable and this may cause students to lose confidence in the computer or make them feel that it 'has no idea', which encourages them to reject the whole system.

Be that as it may, current experiments have shown that average to poor students are on the whole in favour of this type of system as the mistakes which they make in their answers to the tests remain 'confidential' (neither the teacher nor their classmates know about them), and they are not penalized by low marks. On the whole, experience has shown that the learning process is in many cases more efficient when there is no fear of penalties following an unsatisfactory response. Only outstanding or very gifted students are discouraged by the tests, as they almost always take the extremely simplified form of multiple-choice questions, which give the student no opportunity to shine. But this is not very important, as the system is available to those students who wish to make use of it, and no one is obliged to use it if he does not want to.

2.7.3 - The computer as an instrument for evaluation for the teacher

The objectives of this type of C.M.I. use are extremely ambitious, as they place the computer at the centre of the educational process.

The adoption of this method requires:

(a) the division of a complete annual course in a specific subject into weekly lessons, the content of each lesson being defined with great precision;

(b) the preparation of a series of pre-tests and post-tests for each lesson. In fact, three levels of tests must be planned for each lesson, designed respectively for gifted students, average students and poor students. There must also be an automatic evaluation of the answers to the initial tests so that each student can be directed towards the series of tests corresponding to his category;

(c) the preparation of a list of subjects for study or further study leading up to the following lesson for each of the three levels (gifted, average, poor) and based on the results obtained by each student in each series of post-tests.

When this initial work has been completed, the corresponding programs must be written, adding modules which will:

(a) store in the computer the series of test results, week after week, and deduce from them a learning profile for each student;

(b) sort and reorganize this information in order to provide each student with a weekly report drawing his or her attention to his or her weak points;

(c) supply this information to the teacher, along with a set of statistics on the average performance of the class prepared on the basis of individual records.

The operation of this type of C.M.I. system can take several forms:

at the beginning of the school year, all the students in the class take a series of tests in order to check that their basis of knowledge is sufficien for them to follow the course. Students with gaps in their knowledge are provided by the computer with an individual list of subjects for study in order to bring them up to the required level;

each week, all the students in the class take a post-test on the content of the week's instruction, designed to assess their assimilation of its content The computer responds with a diagnosis for each student and diagnosis for the teacher enabling him or her to assess the progress made by each student;

after the post-test on what has been learned in the past week, all the students take a pre-test on the content of the instruction planned for the following week. On the basis of the results obtained in the post-tests and pre-tests, the computer provides each student with a list of subjects for study and sets exercises to be done in preparation for the following week.

Beyond this point, two different teaching approaches can be adopted. The teacher can teach in the usual way during the week, using the information provided by the computer to adjust his strategy, while the weakest students can supplement the lessons with work recommended by the computer. Or, alternatively, he can drop class-teaching altogether, in which case the corresponding periods will be used by the students to do the work prescribed for them, on an individual basis, by the computer, while the teacher gives closer attention to those students experiencing difficulties identified by the computer.

Observations: the very ambitious objective of this type of C.M.I. is to personalize tuition, enabling each student to make progress during the school year not at his own rate, as the content of the instruction is the same for everyone, but rather in his own way, by adapting the content of each lesson to his personality. Some experiments have been conducted in order to determine, by computer, the modes of learning which are preferred by students (visual, aural, kinesthetic) and, also, what is known as their 'cognitive style' (from the abstract to the concrete or vice versa) in order to tailor the instruction yet more closely to individual characteristics. The result of these experiments appear to indicate, as has been said, that this type of method improves the performance of average students but is not popular with outstanding students, who complain of the tedium of the system imposed on them. Uses of this type of C.M.I. system are also very difficult to develop, and it imposes a standardized rate of progress on all the teachers involved (the content of each course is determined in advance for the whole school year).

2.8 - Conclusion

The administration of teaching processes by computer can take several different forms, the two main forms being the provision of assistance to students, who may use the system as and when they wish, and assistance for teachers who may in this way keep more closely in touch with the students and provide more effective instruction.

C.M.I. (Computer Managed Instruction) or C.M.L. (Computer Managed Learning) as it is sometimes called, originated in the U.S.A. and the few significant experiments currently being conducted are mainly located in the U.S.A. and in the United Kingdom, although tests along the same lines have also been carried out in Japan and Canada.

All of these experiments are very circumscribed and no definitive conclusions can be drawn from them concerning the effectiveness of the methods used.

In very general terms, the less demands they make of teachers and students in terms of working methods and the amount of extra work they entail the more willingly these experiments are accepted by both groups.

The original idea of replacing teachers by computers equipped with software enabling them to instruct students and manage educational processes is now being strongly challenged. Current research is more concerned with enhancing the educational environment in which the teacher continues to perform a more or less traditional role while using increasingly sophisticated software to assist him in that role, enabling him to provide a more effective form of education which is better adapted to the separate individuals making up the class. Within this framework, the various C.M.I. and C.A.I. techniques may be of great assistance to him in training students for tomorrow's computerized society.

## 3. COMPUTER-AIDED INSTRUCTION (CAI)

### 3.1 Introduction

The first experiments in CAI were carried out in the late 1960s. At the time the only technique used was the 'tutorial method' still called 'programmed instruction'. Each item of knowledge to be assimilated was divided into sub-items according to complexity; a short piece of information was displayed and immediately followed by a question designed to check that the information had been correctly assimilated.

Other techniques rapidly appeared, such as:

computer drill and practice;

the dialogue method, which enabled the student to ask the machine questions within a limited semantic field;

the 'data bank consultation' method;

the simulation method;
etc.

Today, the heading CAI covers all the educational uses of the computer, whether the students work with their terminals by themselves, whether the teachers use it as a teaching aid or whether the students work on terminals under the direction and guidance of the teacher.

3.2 Present situation

In all developed countries there are active policies for the implementation of CAI. In many countries, there are government incentives or plans to install micro-computers in primary and secondary schools and institutes of higher education, for both scientific and technical instruction and general education.

In addition, micro-computer manufacturers have also been promoting CAI because of the huge market the education system represents.

Finally, in numerous countries which have their own computer industry (Australia, France, Japan, United Kingdom, USSR, etc.), governments have been trying to make the education market a special outlet for the national computer industry, thus providing it with indirect financial aid to assist its development.

On the whole, however, CAI remains a fringe activity in all countries because of the many problems involved in extending its use on a large scale:

technical problems related to the installation of computers in schools (available space, maintenance, use, etc.);

teacher training in the use of equipment and software;

CAI programmes, of which only a small selection is available and which are very costly to develop;

financial difficulties, related to the purchase of equipment and its periodic replacement as well as the expense involved in solving the problems listed above.

3.3 The state of the art

We shall describe the state of the art in hardware, programming and teacher training.

Hardware

Most of the hardware used consists of low-cost micro-computers with a small memory and a monochrome, alphanumeric only cathode ray tube display unit (16-24 lines of text but no graphic display possibility), which limits the range of educational applications quite considerably.

It can nevertheless be hoped, given the continuous decline of computer costs, that powerful micro-computers will soon be available at reasonable prices, with high resolution, colour cathode ray tube screens that can display both texts and drawings simultaneously, thus providing for less rudimentary educational applications than those afforded by the hardware currently in use in schools.

Programming

Regardless of the simplicity or sophistication of the hardware, programmes are obviously the central problem in CAI. Since the creation of CAI, they have been written by teacher/researchers either under contracts funded by research bodies or as volunteer work outside normal working hours.

It is currently estimated that 100 hours of work are needed to develop a programme corresponding to one hour of use by a student, and if more sophisticated hardware is used (graphics, colour, music or voice output, etc.), it will take longer.

Such a situation may be normal during the experimental phase but it is incompatible with the phase of general use we are now entering. This phase is characterized by widespread diffusion of CAI software, but a research group obviously cannot be expected to reproduce software on a large scale or to market, distribute and maintain it. This all requires substantial investment and an effective commercial network.

In a great many countries, given the extent of this potential market, either specialized companies are being created to do this work or publishing houses have taken it over.

In both cases, the companies hire groups of specialists to design the educational part of the programme, supplying them with tools to help them ('author languages', graphic programmes, programming assistance, etc.) and conduct the commercial side of the operation themselves.

This is a recent phenomenon which has been developing sporadically, since textbook publishers in particular can sense the potential of the CAI market and want to be in on it, but they are cautious in their investments because, while the market has enormous potential, for the time being it is extremely limited due to the small number of computers currently used in schools and homes (an estimated 500,000 micro-computers are used in the United States of America for education for a school population of approximately 40 million, whereas in France the goal is 100,000 micro-computers in 1986 for a school population of approximately 10 million and the United Kingdom hopes to have a micro-computer in every school by 1986).

The quality of existing CAI programmes is far from being universally acclaimed, and it is true that many of them simply reproduce on the computer conventional teaching methods to which the use of computers adds very little. It is also true, though, that original programmes applying new methods that could not be used without computers are gradually being developed, but they are only a minority; research in the field remains essential if the best possible use is to be made of computers.

Teacher training

Experience in industry, trade and administration, which had showed early on that it was essential, before computerization, to train users in the systems to be installed, was slow to be absorbed in education.

In addition, in a great many cases, when the problem did arise, teachers were trained in computer programming instead of in computerized teaching methods, that is, instead of being taught about the teaching methods and techniques made possible by CAI.

The importance of the problem of CAI teacher training seems to have been acknowledged now, since experience has shown that when computers are installed overnight in a school once the novelty wears off the machines are rejected by the staff en masse because they do not know how to use the computers to teach the different subjects. In such cases, the computers are only used outside school hours in 'computer clubs' organized by one or two computer enthusiasts on the staff who enjoy programming with a small number of volunteer students.

### 3.4 Conclusion

CAI undisputably has great potential to bring about improvements in teaching methods.

Progress has nevertheless been relatively slow, despite official encouragement and funding and CAI is, for the time being, a fringe activity in all educational systems.

Before CAI can be brought into general use certain problems must be dealt with:

low priced computers are not adequate;

there are very few good quality CAI programmes that can be used on several computer models;

little attempt is made to train staff in the use of CAI.

In addition, the appearance of new technologies (computer-linked videodisks, voice input and output, high resolution colour display screens, microcomputer networks, etc.) in the near future is likely to modify the current methods of CAI use and lead to new applications.